(5) Estimates of cost of complete control of noxious species, together with amount of probable saving that would result.

6. Beneficial animals and their preservation.
   (1) What animals are beneficial?
   (2) Relation of age of species to problem of its preservation.
   (3) Effect of occupation by man on animal community.
   (4) Essentials for conservation.
      (a) Maintenance of seed-stock; determination of annual toll permissible; unfair methods of destruction; effect of legislation on game conservation.

7. Noxious animals and their destruction.
   (1) What animals are noxious?
   (2) Methods of control; rodents, predatory animals, other groups.
   (3) Effects of extirpation of wild species on the natural balance.

By way of summary, may I repeat that present day world politics emphasize in unmistakable terms the vital necessity of increase in food production. For permanent increase in the productivity of the land further study is called for of the scientific fundamentals on which agricultural practise is based. The ecologic method of approach promises much of value. The problems are vast and lead inevitably to the stressing of the strategy of cooperation as an essential to their successful solution.[3]

WALTER P. TAYLOR
BIOLOGICAL SURVEY

[3] The symposium on the relations between government and laboratory zoologists held in connection with the meeting of Section F at the sessions of the American Association for the Advancement of Science, Johns Hopkins University, Baltimore, December 28, 1918, emphasized the desirability of better coordination and cooperation between these two large and active bodies of scientific investigators. In this connection the Bureau of Biological Survey solicits correspondence from all who contemplate researches in the ecology of the higher vertebrates, and will be glad to assist with suggestions, advice, or otherwise as opportunity may be given.

THE ATTAINMENT OF HIGH LEVELS IN THE ATMOSPHERE

IT is a far cry from January 7, 1785, to February 27, 1920. On the earlier date Dr. John Jeffries ascending from the cliffs at Dover, made his way through the air over the English Channel to France, landing after an eventful three hours, on the French coast in the forest of Guines.

During the flight his barometer ranged from 1,006 kilobars (29.70 inches) to 789 kilobars (23.30 inches) indicating at the lower reading a height of nearly 2,012 meters (6,600 feet).

On Friday, February 27, this year, Major R. W. Schroeder, chief test pilot of the Air Service, rose from McCook Field at Dayton, Ohio and reached an elevation of 10,979 meters (36,020 feet).

Jeffries of course used a balloon; Schroeder an airplane designed for climbing, and with a supercharger, *i. e.*, a gas turbine centrifugal compresser to offset the loss at the carbureter due to diminished density of the air at such heights.

The history of the attack upon the high levels of the atmosphere may then be said to extend over a period of one hundred and thirty-five years. Various methods and agencies have been employed. Within twenty years from the time of the first ascension, heights of 4,000 meters had been attained. Indeed Gay-Lussac made certain scientific observations at a height of 7,400 meters in 1804.

On September 5, 1862, Glaisher and Coxwell reached a height of 11,200 meters or practically the same level as that reached by Schroeder with an airplane. Three other noteworthy records by manned balloons are those of Tissandier, Spinelli and Sivel, acting for the French Academy, who reached a height of 8,530 meters, on April 15, 1875; Dr. A. Berson who on December 4, 1894, reached 9,600 meters; and later (1901) Berson and Süring to a known elevation of 10,500 meters and probably 10,800 meters, both men being unconscious at the higher level. In all of these high balloon flights, the observers became unconscious, and this even in the

later attempts when recourse to oxygen inhalation was had. In the airplane and Zeppelin ascensions to be referred to later, the observers were provided with oxygen, and what is equally important, body heating devices to enable them to withstand extremely low temperatures.

While not, strictly speaking, a manned balloon, it must be noted that in the famous Zeppelin raid of October 19, 1917, the barographs of the flagship L 49, superdreadnaught, indicated that at least for a short period the airship had attained a height of 6,200 meters. The crew were provided with oxygen tubes and wore electrically heated mittens and boots. There is some doubt, however, concerning the height, owing to the speed of wind and ship.

A brief summation[1] of the extreme elevations attained, up to 1917 is:

By kites, 7,044 meters, Mt. Weather, Va., Oct. 3, 1907.

By manned balloons 10,800 meters, Berson and Süring, July 31, 1901.

By Zeppelin, rigid dirigible, 6,200 meters, October 20, 1917.

By airplane, 7,950 meters, G. Guidi, Nov. 7, 1916.

By sounding balloons, 37,000 meters, 1912.

By pilot balloons, height determined by theodolite, 39,000 meters.

The airplane record has been steadily developed. In 1909 Latham made 161 meters; which was soon surpassed. Drexel in 1910 made 1,829 meters and then in rapid succession Macrane 2,582 meters, Wynmalen 2,800 meters, Drexel 2,880, Johnston 3,193, Loudan 3,280, Parmelee 3,304, Brindley 3,585, and Legagneux, 5,718, a noteworthy jump.

Perreyou on March 11, 1913, attained a height of 6,000 meters.

The war gave a tremendous impetus to the development of the plane; and the necessity of quick and high climbing was fully appreciated by all the belligerents.

Major (then Captain) Schroeder on September 18, 1919, reached a height of 8,809 meters (28,000 feet) at Wilbur Wright Field. Captain Lang and Lieutenant Blowers of the Royal Air Service, in the brief space of 66 minutes, reached an elevation of 9,295 meters (30,500 feet); to be in turn surpassed by Roland Rohlfs at Roosevelt Field, Mineola, who made 9,357 meters (30,700 feet) on July 30, 1919, and again on September 18, of the same year when in the short space of 78 minutes he rose 10,516 meters (34,500 feet) and fluttered back to earth as gently as a snowflake drops.

Mention should also be made of the flights of Adjutant Casales on May 22, 1919, to 9,449 meters, June 8, 9,495 meters, and on June 14, to 10,100 meters (33,136 feet).

The record now stands Schroeder, February 27, 1920, 10,979 meters. Thus in a period of ten years the heavier than air machine has been so improved that elevations have increased from 500 to practically 11,000 meters. We are told that the goal of American aviators is 12,000 meters or approximately 40,000 feet, but it is of course, possible that this ceiling shall be lifted still higher, and that a height of 15 or even 16 kilometers (10 miles) may be reached, provided suitable protection (so-called diving suits) for the airman is available.

In Schroeder's latest ascent, the oxygen supply was exhausted and the results were tragic but fortunately not fatal.

The fact that heavier than air machines can be driven to the 10-km. level means much to the aerographer, particularly in connection with forecasting weather changes at the surface. This is the most important level for studying not only pressure, temperature and water vapor content, but the air flow and structure of cyclone and anticyclone. The 10-kilometer level is the bottom of the stratosphere or isothermal region and at the same time the top of the troposphere or convectional region. As a postulate to Dines's statistical studies we know that in the stratosphere or region above 10 kms. it is colder in an anticyclone than in a cyclone at the same level, while on the other hand in the troposphere, *i. e.*, from 9 kms. down to 1 or 2 kms.

[1] From "Principles of Aerography," p. 19.

it is warmer in the anticyclone than in the low. This holds for Europe but is not entirely confirmed for the United States. The height of the base of the stratosphere varies in Europe with cyclonic and anticyclonic weather from about 8 to 13 kms. It also varies with latitude, averaging 9.6 at Petrograd; 10.6 in England; 11 in Italy; and 11.7 in Canada.

Thus it can readily be predicted that at a height of 10 kms. in the latitude of New York an airman rising on an afternoon in the early fall will experience a temperature lapse or vertical decrease amounting in all to 200 kilograds, *i. e.*, from 1,050 to 850 kilograds, using a scale on which the absence of all molecular heat is represented by 0 and the ordinary freezing point by 1,000. On the Centigrade scale this would be from 14° above freezing to 41 degrees below freezing.

If our atmosphere were homogeneous, we should reach its top at a height of 8,000 meters. There would then be no need of superchargers; and oxygen tanks would be advantageous but not absolutely indispensable. But this does not occur in nature and the density of our aerial envelope at 8,000 meters is actually 40 per cent. of what it is at the surface. At 10,000 meters it is just 33 per cent. of the surface density.

Km.	Kk.	Kb.	*gm/m³*.
20	783	55	87
19	787	63	102
18	783	74	121
17	772	87	144
16	772	102	169
15	772	120	198
14	776	142	233
13	783	167	268
12	790	195	314
11	802	228	365
10	816	266	415
9	838	309	470
8	864	358	528
7	890	413	592
6	920	475	662
5	945	543	733
4	967	618	815
3	989	703	905
2	1,008	798	1,011
1	1,018	903	1,134
0	1,033	1,017	1,258

The preceding table somewhat modified from the data given by Dines in his recent paper on the "Characteristics of the Free Atmosphere" indicates the average temperature, pressure, and density of the air at various heights. The height is in kilometers, temperature in kilograds, pressure in kilobars and density in grams per cubic meter.

Schroeder's thermograph indicated a minimum temperature of —55 degrees C. (or 99 degrees below freezing on the Fahrenheit scale). This on the new temperature scale is 799. It will be seen that this temperature indicates a height of about 11,000 meters.

In one of Rohlf's ascents he went beyond the top of the troposphere or above what might be called the temperature lid. On that date, the base of the stratosphere was below 10 kilometers and, therefore, he passed into a somewhat warmer level even though at a greater elevation.

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THE SEPARATION OF THE ELEMENT CHLORINE INTO CHLORINE AND META-CHLORINE

ALTHOUGH many attempts have been made to separate an element into two or more different atomic species, in no case have the experiments met with success. In my opinion this has been due largely to the fact that in all cases where it is *known* that isotopes exist, as in the element lead, the conditions imposed upon the experiments by the relative atomic weights of the different atomic species are such as to be extremely difficult to meet. For this reason, when five years ago I decided to make a separation of an element into isotopes, it seemed that it would be easier to separate the isotopes in an element where isotopes were not known to exist, than to meet the extremely arduous conditions of the known cases.

In 1915 I gave conclusive evidence that chlorine, magnesium, and silicon (in addition to neon as discovered by Thomson), among the light elements, are mixtures of isotopes, and that the atomic weight of the lighter isotope is 35.0 for chlorine, 24.0 for mag-